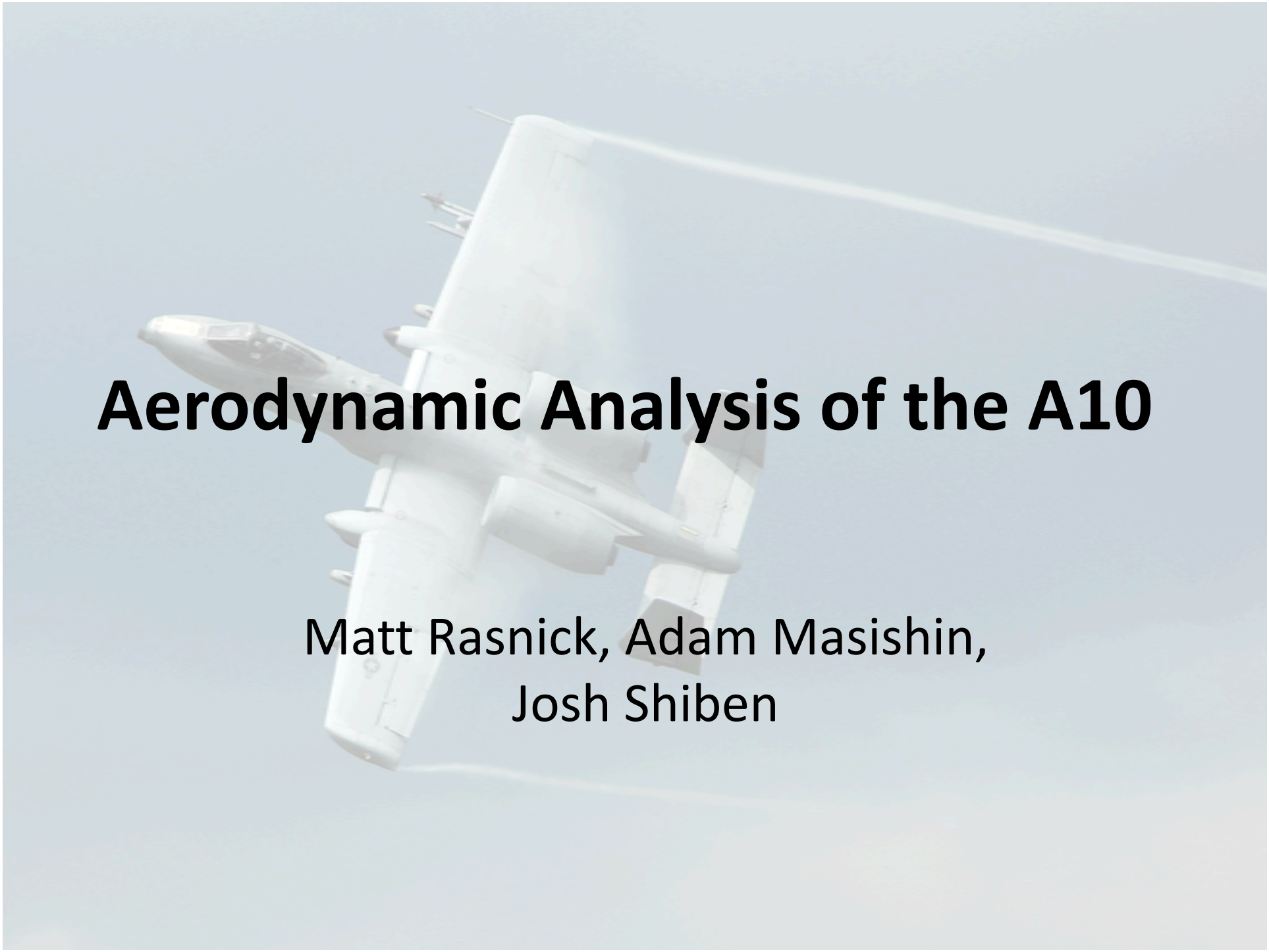


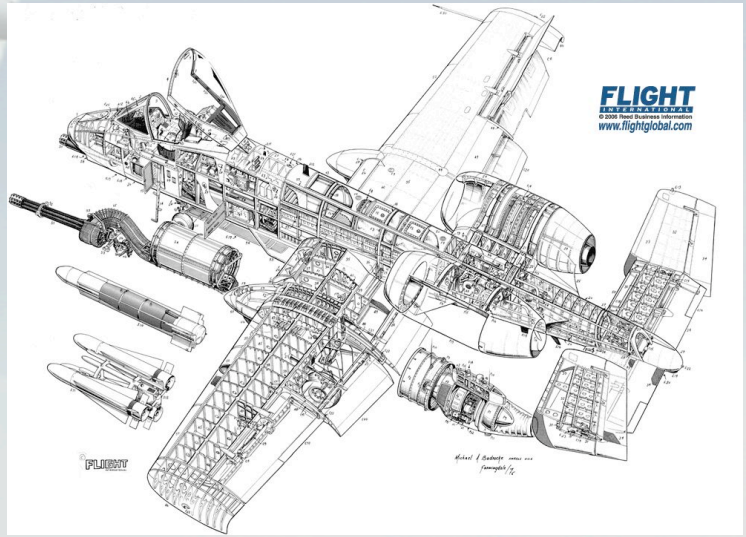
Aerodynamic Analysis of the A10

Matt Rasnick, Adam Masishin,
Josh Shiben

Description of the A-10

- The A-10 was built to fill the need for a close air support, ground attack vehicle

- It is heavily armed, capable of carrying multiple laser guided munitions, along with its primary weapon : a built in 30mm GAU-8/A Avenger Gatling Gun
[Gun Test Video]
[Aftermath]



- The A-10 is designed to survive, and remain flying even when suffering massive damage

- Low wing loading of 200 kg/m^2 (40 lbs/ft^2)

www.flightglobal.com

Key Flight Conditions

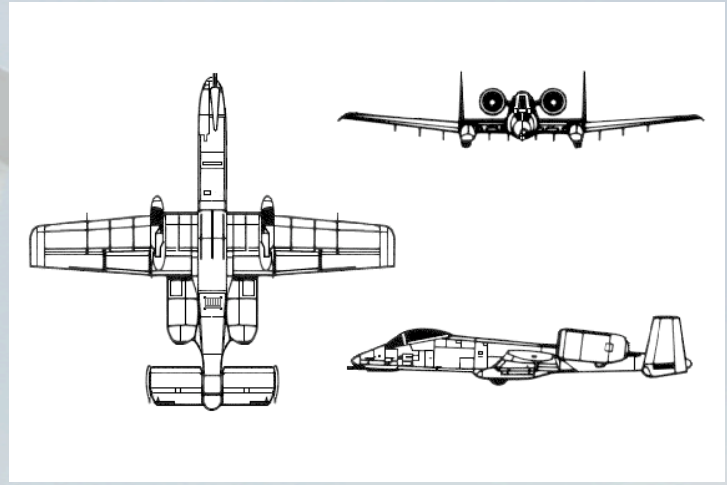
- Cruise Speed
  - 1525 m
  - 173.1 m/s
  - M=.521
- Combat Speed
  - 1525 m
  - 196 m/s
  - M=.590

www.wikipedia.org/wiki/A-10

Tornado Model Geometry

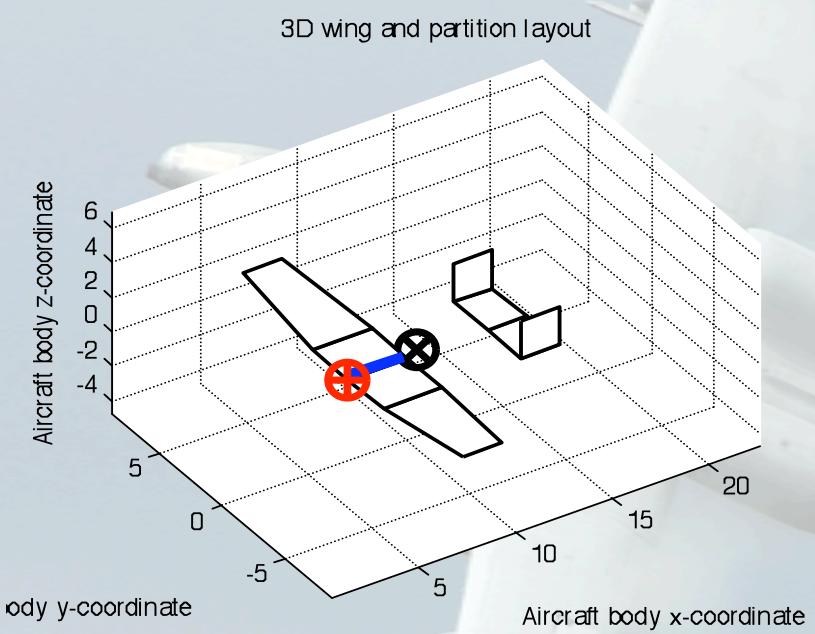
Nose Considered (0,0,0)

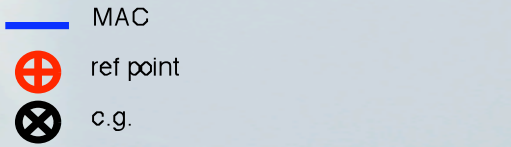
- CG (wings only) = (10.6, 0, 0.26)
- Wing
  - Apex = (7, 0, 0)
  - Partition 1
    - Root Chord = 3.04 m
    - Half -span = 2.8 m
    - Sweep = 0
    - Dihedral = 0^{o}
    - Taper = 1
    - Root Airfoil – 6716
    - Tip Airfoil – 6716
    - -1^{o} Incidence
  - Partition 2
    - Root Chord = 3 m
    - Half-span = 6 m
    - Sweep = 0
    - Dihedral = 7^{o}
    - Taper = 0.65
    - Root Airfoil – 6716
    - Tip Airfoil – 6713
    - -1^{o} Incidence
- Tail
  - Apex = (14.2, 0, 0)
  - Partition 1 (Horizontal)
    - Root Chord = 2 m
    - Half -span = 2.7 m
    - Sweep = 0
    - Dihedral = 0
    - Taper = 1
    - Root Airfoil – 0012
    - Tip Airfoil – 0012
    - No Twist
  - Partition 2 (Vertical)
    - Root Chord = 2.1 m
    - Half-span = 2.2 m
    - Sweep = 0
    - Dihedral = 90^{o}
    - Taper = 1
    - Root Airfoil – 0012
    - Tip Airfoil – 0012
    - No Twist

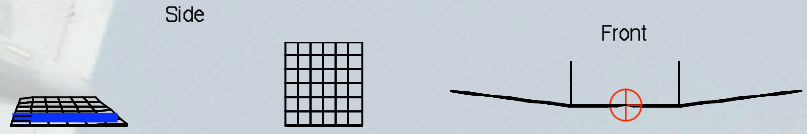


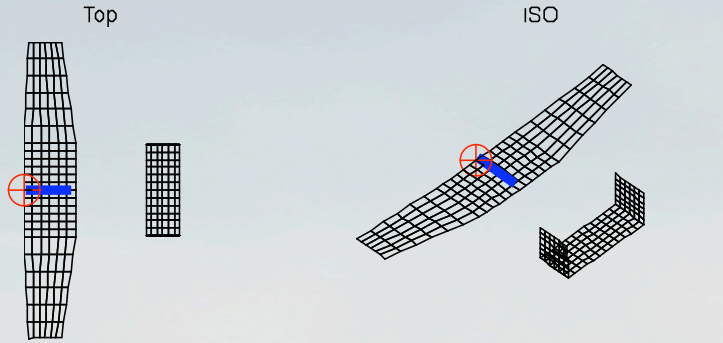
Jane's 1983/84, p 375-6
Jane's 1986/87, p 402
http://en.wikipedia.org/wiki/File:FAIRCHILD_REPUBLIC_A-10A_THUNDERBOLT_II.png

Tornado Geometry/Panel Output



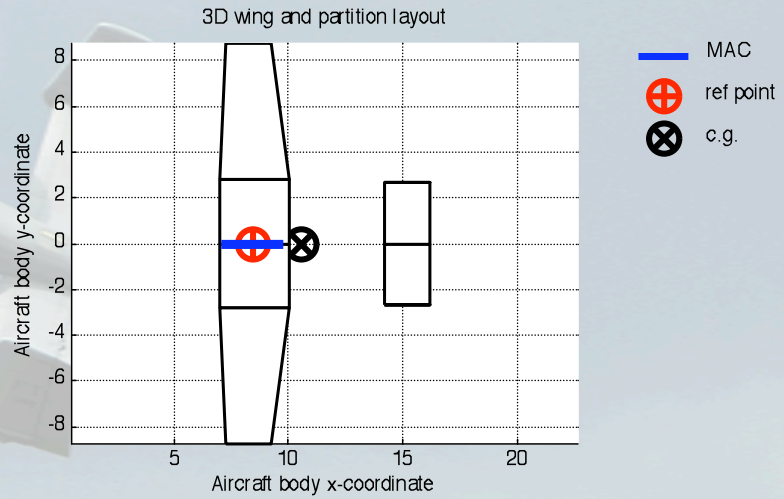




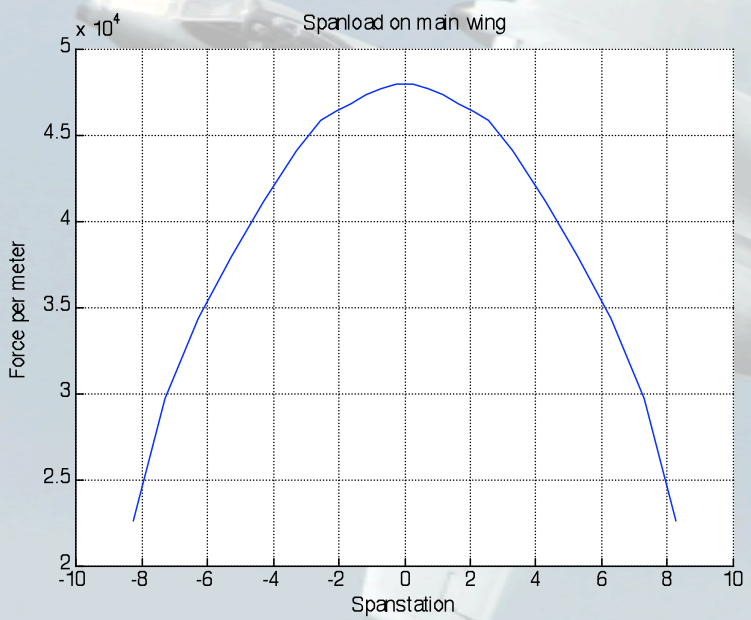


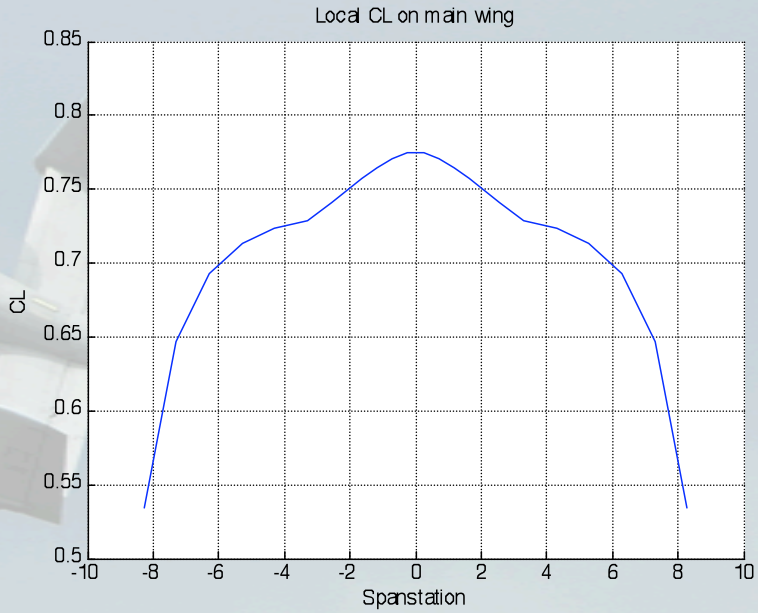
Neutral Point

- @ 8.45 m from nose
- Results in static margin of 13.1%
- Within 0.1% for all flight conditions

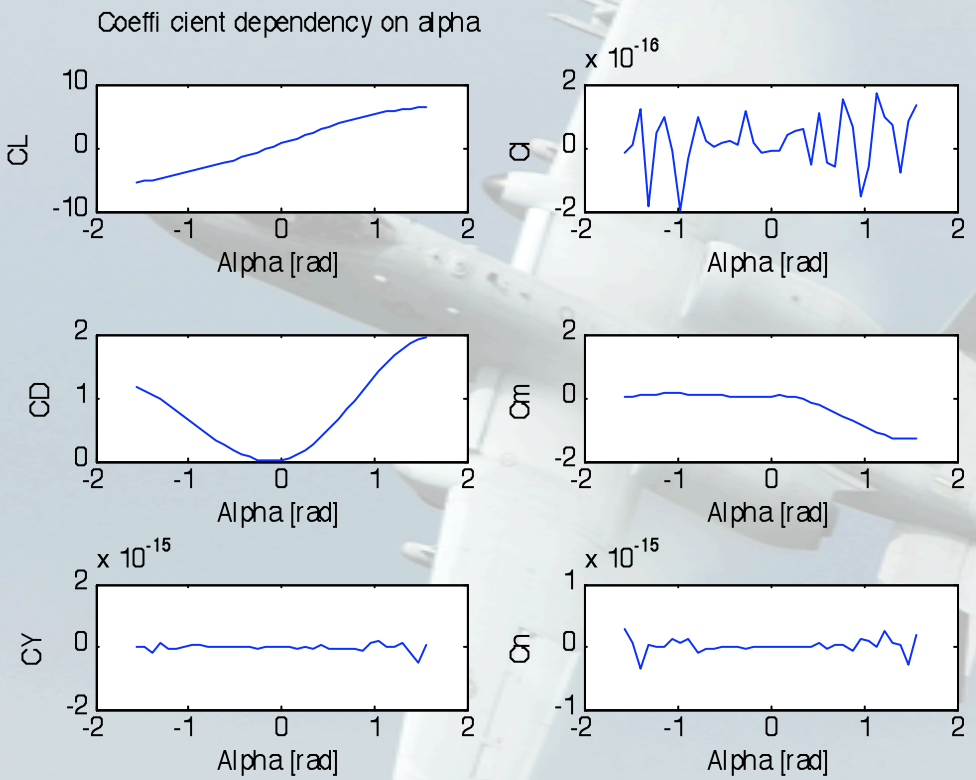


Spanloading of Wing, Local C_l Plots For Combat Strafing/Bombing Runs





Alpha Sweep for Combat Run -90:5:90



awwar.com

Damage Analysis

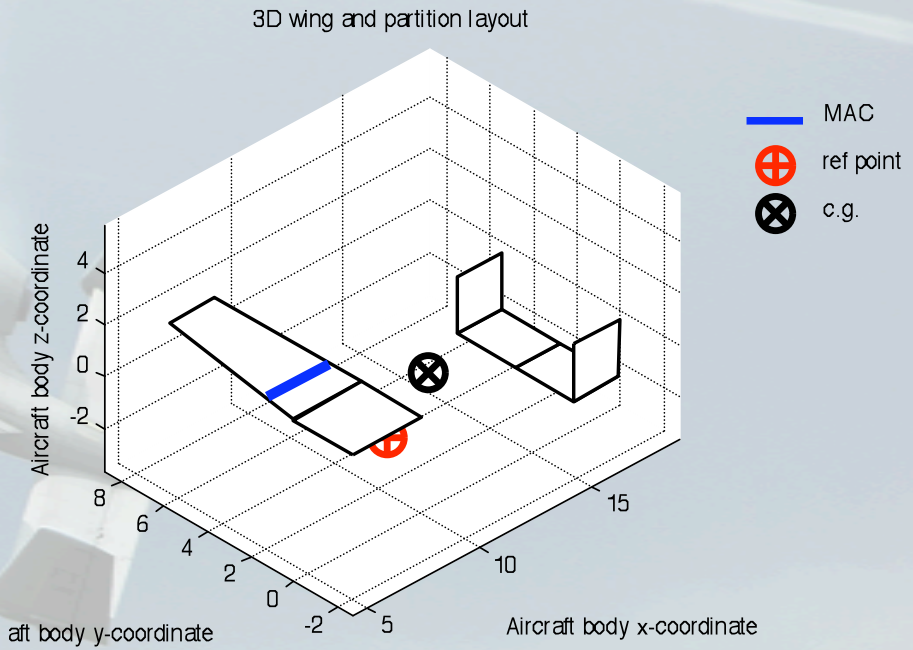
- The A-10 is designed to absorb massive amounts of ground fire and remain flying

http://www.teamwarthog.org/html/history.html

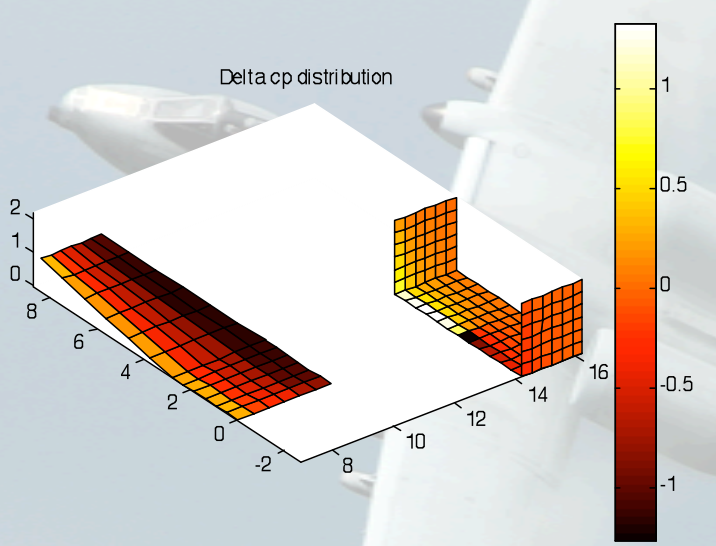
www.kowabunga.org

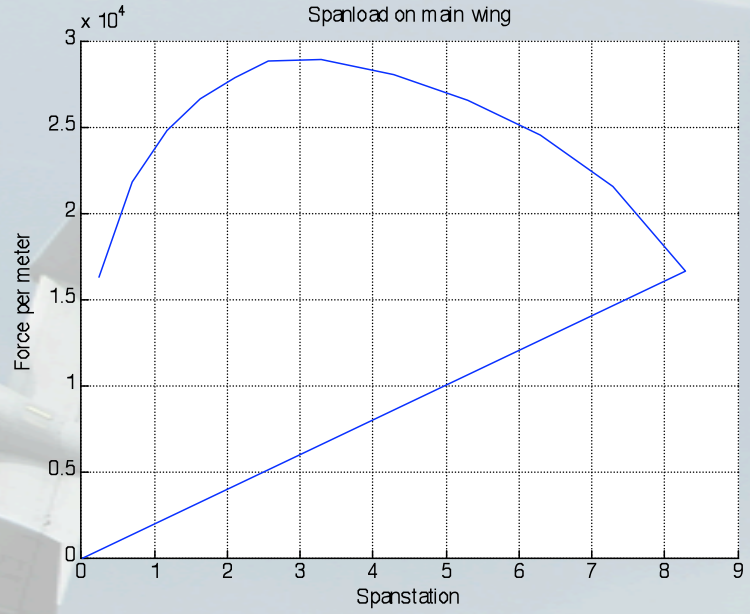
Damage Example

- Assume 1 wing shot off
- CG based on wings, but also assumed that a fuselage was present so that the CG wasn't as skewed



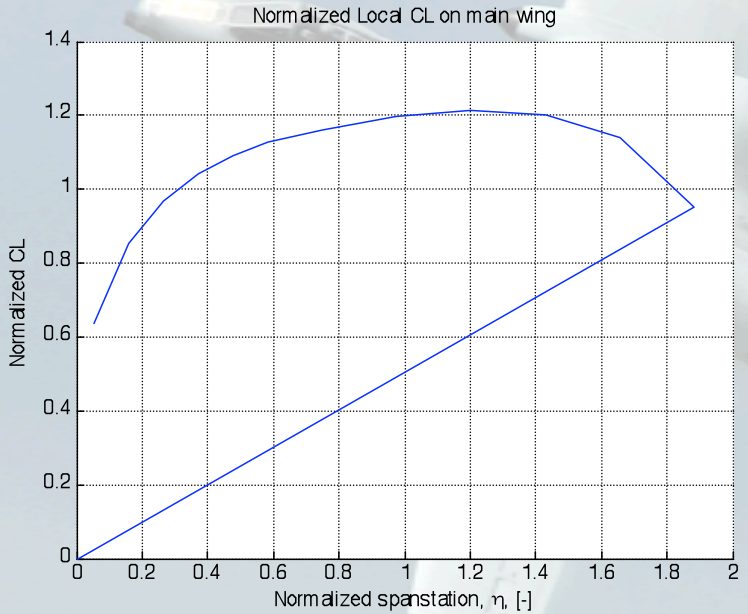
Spanload with Damage





Spanload shifted outboard from before, and now the tail must make up a lot of the lost lift

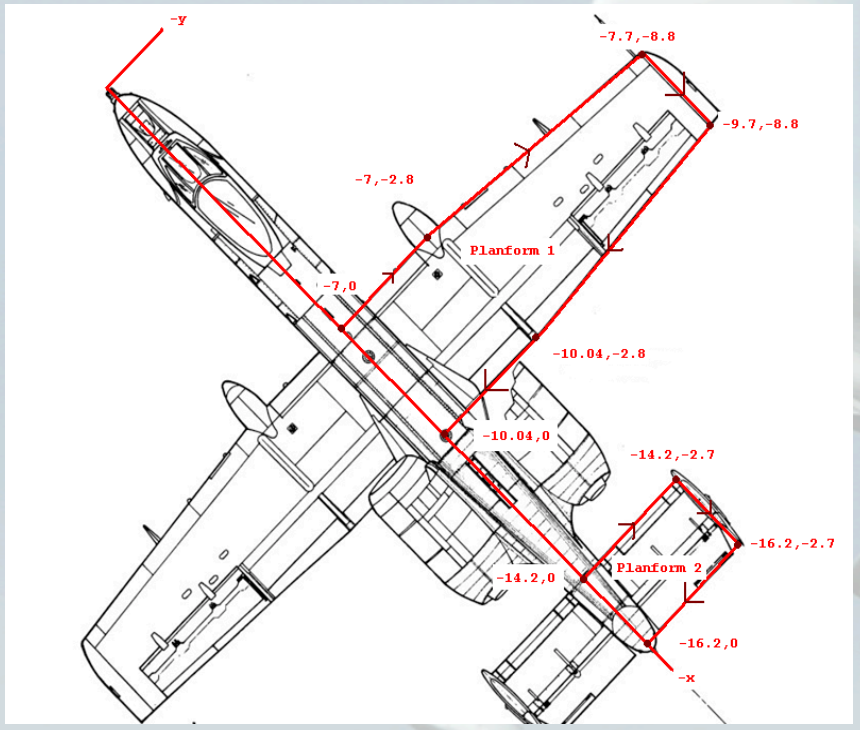
C_l with Damage



- Increased C_l on wing to make up for lost lift, but a max C_l of 1.2 still is within reason

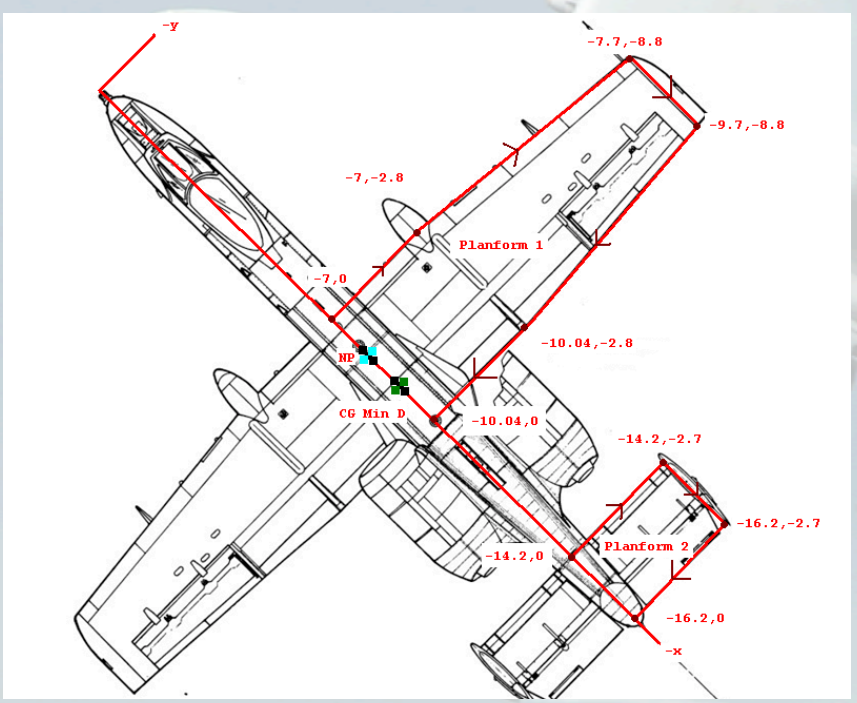
www.wikipedia.org/wiki/A-10

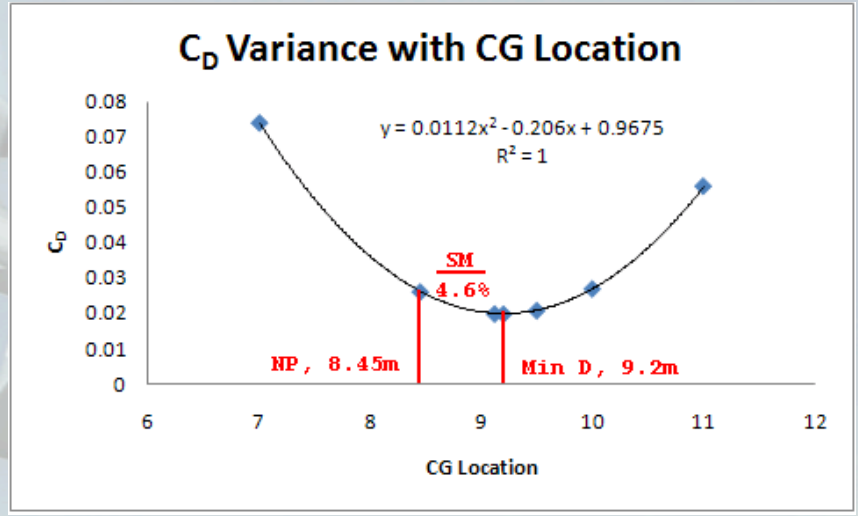
LamDes Modeling



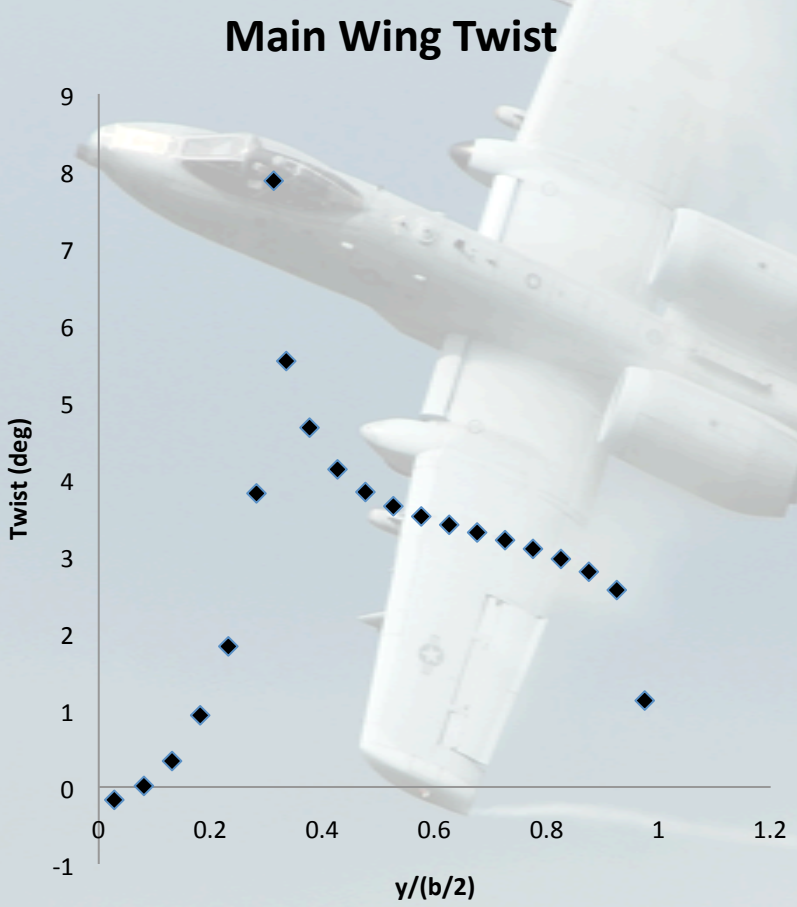

```
LamarDesign Program - A-10 Thunderbolt -
  2.00     -8.45      3.04       43.64       0.0         0.0
    0.0
  5.          0.          0.        -0.00      .4          .2
 -7.00        0.00       -0.0        1.
 -7.00       -02.8       -7.0        1.
-7.70        -08.8       -7.0        1.
-9.70        -08.80      -7.0        1.
-10.04        -02.80      -0.0         1.
-10.04        -00.00
  3.           0.          0.        .20        .4          .2
-14.20        -00.0       0.          1.
-14.20        -02.7       00.       1.
-16.20         -2.70         00.       1.
-16.20         -0.00
1.0   10.0 20.   0.3   0.58 40.0   0.0006
 0.65         0.65        0.0        -0.00      1.0
 0.030       1.0         0.0         0.0        0.0         0.0
```

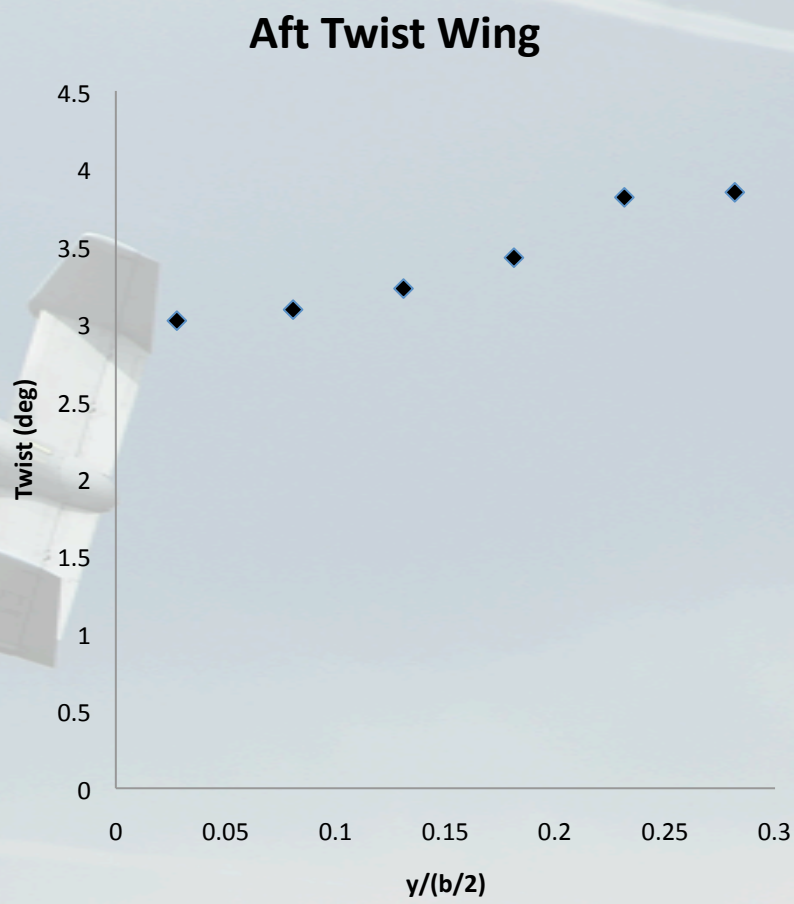
Static Margin



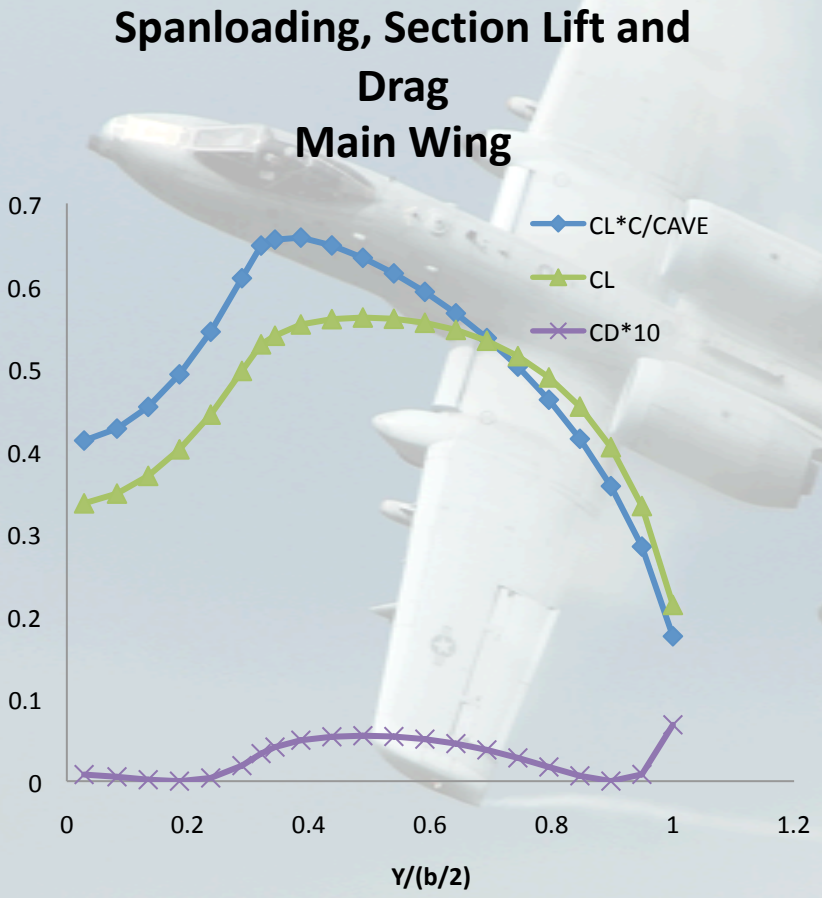


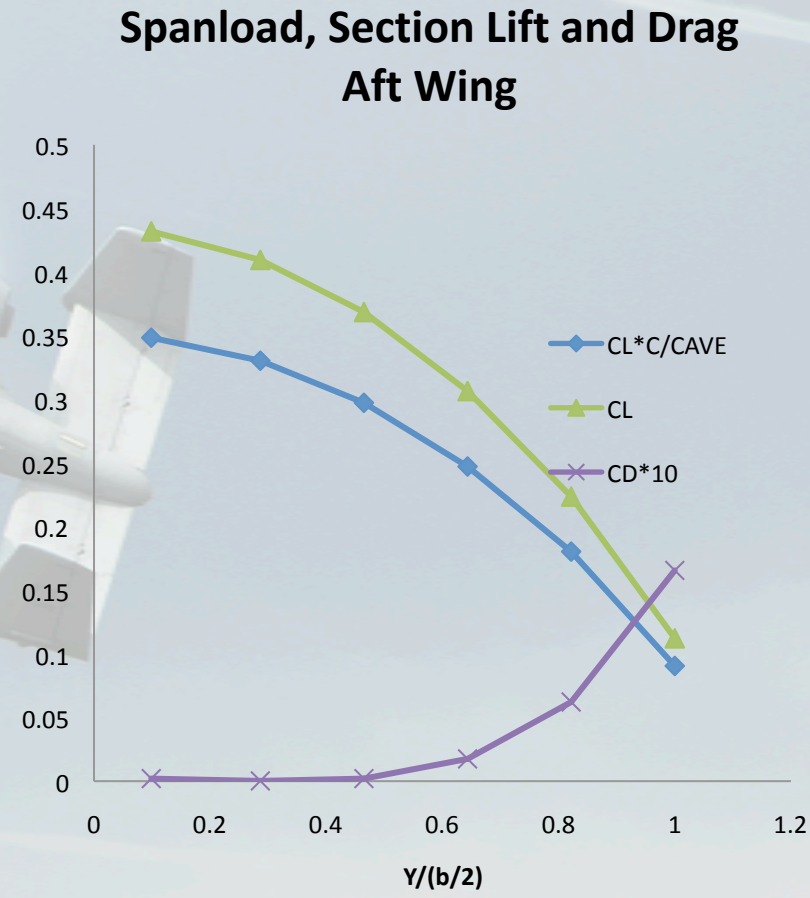
Wing Twist


Main Wing Twist
Twist (deg)
9
8
7
6
5
4
3
2
1
0
-1
0
0.2
0.4
0.6
0.8
1
1.2
y/(b/2)


Aft Twist Wing
Twist (deg)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.05
0.1
0.15
0.2
0.25
0.3
y/(b/2)

Spanloading





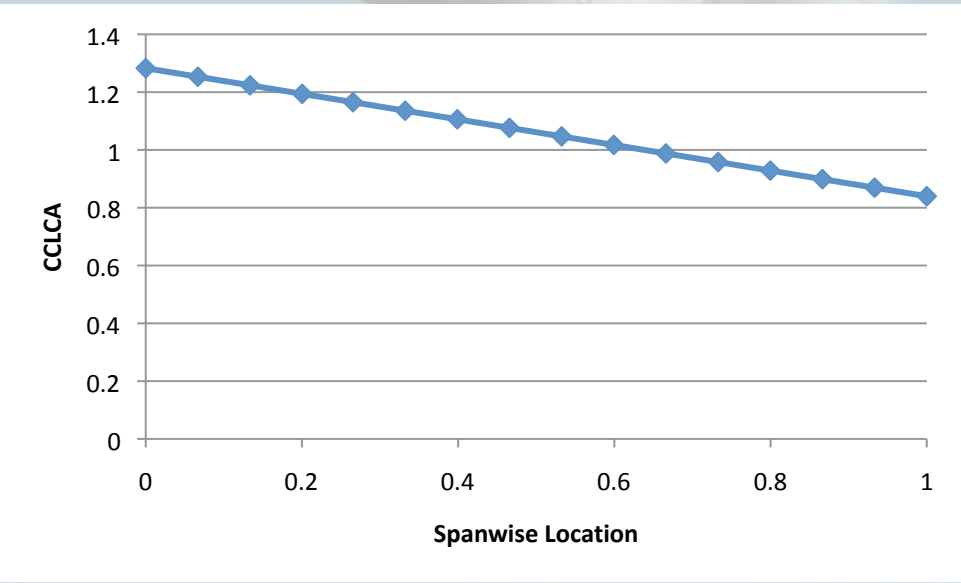
A-10 Takeoff

- A-10 is built to takeoff on short and rugged runways
- It can take off fully loaded (22,950 kg) in 1,220 m
- Only high lift systems are 2 segment, 3 position Fowler Flaps and a very small inboard leading edge slat

http://www.geocities.com/tacticalstudiesgroup/a10roadtakeoff.jpg

A-10 Lidrag

- e=.858
- CL=1.049



A-10 Friction

Component	Wetted Area (m^2)	C_F	ΔC_D
Fuselage	61.80	0.00212	0.00288
Canopy	6.97	0.00256	0.00041
Twin Engines	25.28	0.00270	0.00147
Wing	94.02	0.00263	0.00726
Horizontal	16.62	0.00293	0.00139
Twin Vertical Tail	8.72	0.00298	0.00074
Total	213.41	0.01147	0.01415

All data was found at M=.56, at the standard cruise alt (1525 m)

www.wikipedia.org/wiki/A-10

Questions?